GOVERNMENT OF INDIA
SCIENCE AND TECHNOLOGY
LOK SABHA

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CONFERENCE ON SCIENCE CONGRESS
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Will the Minister of SCIENCE AND TECHNOLOGY be pleased to state:

(a) Whether attention of the Government has been drawn to the warning given by the Scientists of the National Physical Laboratory in the Conference of Science Congress that the climatic changes in the country in the near future, may cause drastic decline in the paddy and wheat production as also serious crisis of drinking water for the urban population;

(b) If so, the details thereof alongwith the other anticipated problems in this regard; and

(c) the concrete steps taken by the Government to face these problems?

Answer

MINISTER OF STATE FOR SCIENCE AND TECHNOLOGY (SHRI BACHI SINGH RAWAT)

(a) The effects of climate change on agriculture and water availability were mentioned in an invited talk at the Indian Science Congress 2001 by the former Director NPL and former Director General CSIR.

(b) Climate change is caused by increasing concentrations of greenhouse gases (like carbon dioxide, methane, nitrous oxide, CFCs, tropospheric ozone etc.), precursor gases (like carbon monoxide, oxides of nitrogen etc.) and aerosols in the atmosphere. Climate change may lead to increased precipitation, change in monsoon patterns and reduction in sunlight. In the long term these could have effect on the present system of agriculture inter-alia rice and wheat crops and availability of water. Increased loading of aerosols in the atmosphere due to inefficient fossil fuel usage etc. could contribute to respiratory problems.

(c) India participated in an international collaborative programme named Indian Ocean Experiment (INDOEX), which undertook detailed studies on the composition, size, distribution, transformations and dynamics of aerosols over the Indian region. Government has initiated policy measures that seek to reduce the effects arising out of fossil fuel usage by promoting improved automotive fuels, setting up stringent pollution norms and providing incentives for use of non-conventional energy sources etc.

Executive Summary:

The main factors responsible for climate change are increasing concentration of greenhouse gases & trace precursor gases and aerosol loading due to anthropogenic activities. The equatorial Indian Ocean provides a vast unique natural laboratory to observe and study the chemical interactions between gases and particulate matter, the particulate matter and clouds and radiation properties of the particulate. This is the only place in the world where an intense source of continental aerosols, anthropogenic trace gases and their reaction products (e.g. sulphate and ozones) from northern hemisphere is directly connected to the pristine air of the southern hemisphere by a cross equatorial monsoon flow into the Inter-tropical Convergence Zone (ITCZ).

The Indian Ocean Experiment (INDOEX) was an international multi platform field campaign to measure long range transport of air pollution from South and South-East Asia towards the Indian Ocean duringJanuary to March 1999. Surprisingly, high pollution levels are observed over the entire northern Indian Ocean toward the ITCZ at about 10oS.The aerosol mass loading observed over the Indian ocean and the presence of thick layers of aerosols reduce the incoming solar radiation and alter the radiation balance of the earth system. These aerosols are expected to have originated from the anthropogenic activities, like biomass burning, fossil fuel consumption etc. and are found to cover very large region as seen from the recent Indian Ocean experimental results. This may result in the modification and change in the monsoon pattern over the Indian region, affecting agriculture and the availability of water. Quantitative implications are now under study.

A matter of serious debate is the relative importance of biomass and fossil fuel burning and automobile exhaust. A key requirement is a quantitative assessment of emission of aerosol of different categories from different sources from the Indian sub-continent especially those of black carbon and organic carbon.

Indian Ocean Experiment (INDOEX)

Background:

1. There is a general consensus about the phenomena of Climate Change which is being caused by several reasons such as

increasing concentrations of greenhouse gases like (carbon dioxide, methane, nitrous oxide, CFCs, tropospheric ozone etc.), trace precursor gases (like carbon monoxide, oxides of nitrogen etc.) and aerosol loading due to anthropogenic activities. Aerosol particles of different sizes and composition, play an important role in the control of many atmospheric processes like visibility, radiation balance , air pollution, cloud formation etc. The outstanding problems in Climate Change are those at the intersection of various disciplines of physics, chemistry, biology, dynamics and human intervention but it is difficult to translate this awareness into action, in part, because of lack of adequate observations of such inter-disciplinary phenomena.

2. The equatorial Indian ocean provides a vast unique natural laboratory to observe and study the role of aerosols on the radiation budget in this area. This is a place in the world where continental aerosols, anthropogenic trace species and their reaction products from northern hemisphere are transported south wards during the Jan.-March period and meet the pristine air of the southern hemisphere identified by the Intertropical Covergence Zone (ITCZ). The unique feature of this region is the fact that the region south of ITCZ (10oS) is essentially uninhabitated where pristine conditions are prevailing. However, the region north of ITCZ (north of equator) has lots of anthropogenic activities like agriculture, industries, biomass burning, shifting cultivation, transport etc. Because of this convergence of pollutants and aerosols laden air of the north of ITCZ with the pristine air form the south, there is an excellent opportunity to observe the role of ITCZ in the inter-hemispheric transport of trace gases and pollutants and to study how anthropogenic and natural aerosols alter radiative forcing.

The observations on both sides of the ITCZ may thus provide data to assess:

- The role of continental and marine aerosols in the global radiative forcing.
- The magnitude of the solar absorption at the surface and in ITCZ cloud systems.
- The role of the ITCZ in the transport of trace species & pollutants and their resultant forcing.

Programme Implementation

3. An international programme called Indian Ocean Experiment (INDOEX), was designed some time in 95-96 with participating countries like India, USA and a few countries in Europe, Mauritius and Maldives. The three Co-Chief scientists of the programme were Dr. A.P. Mitra from India, Dr. Paul Crutzen from Germany and Dr. V. Ramanathan from USA. The primary goal of INDOEX has been to study natural and climatic forcing by aerosol and feed back on regional and global climate.

4. In India this programme has been adopted as a national programme initiated during the mid of 1997 for three years under the sponsorship by DOS, CSIR, DST, DOD and DOE (MIT) - DOS being the nodal agency. The financial support has been to the tune R 150 lakhs equally shared by DOS and CSIR. The contribution of DOD has been to provide oceanographic ship for the two cruises in 1998 and 1999 and that of DOE the connectivity and networking of data. Other ministries like External Affairs, Defence and Home have been associated for examining and according sensitivity clearance required from time to time for the programme.

4.1 The main objective of this programme was to study the climate forcing by aerosols both direct and indirect. The time selected for this study was Jan-March when NE monsoon is active and the prevailing winds are expected to carry pollutants from the Indian land mass through Indian ocean to ITCZ located at this time around 10o S. It was planned to carry out this programme in two phases namely:
(i) First Field Phase in 1998 (FFP-98) and
(ii) Intensive Field Phase 1999 (IFP-99).

Data Collection:

4.2 Data were collected using a variety of platforms (Land based, Ships, Aircrafts, Satellites) on aerosols, ozone and reacting gases (NOx, CO etc.), solar radiation fluxes and cloud properties. The land based stations included Indian stations at Delhi (NPL) Ahemadabad, Mt. Abu (PRL), Pune (IITM), Goa (NIO, Goa University, Dharwad University), Trivandrum (SPL), Kaashidhoo clima observatory in Maldives (A joint operation of Maldives and USA), Port Louis (Joint operation by Mauritius and Indian Institutions like VSSC and IITM) and network of IMD stations for meteorological measurements.

Even before this International INDOEX programme was formally adopted, India took the lead and carried out a number of experiments on board the ORV-Sagar Kanya in 1996 and 1997 by participating as `piggy back` in the already planned cruises for other purposes but covering our region and time of interest. Indian scientists also conducted some experiments with the instruments provided by US groups as a part of collaborative work. The 1996 cruise even at that early stage provided some results on aerosol forcing.

In 1998 during the FFP-98, the platforms used included ORV Sagar Kanya. French constant level balloons were also launched from Goa. In addition observations were also carried out from a chain of Indian ground based stations including Trivandrum, Goa, Dharwar, Pune, Mumbai, Ahmedabad, Mt. Abu, Delhi and Kaashidhoo. In IFP-99 the observations were more intense and platforms used included another US ship RonBrown, different instrumented air-crafts taking off from Maldives and flying at different altitudes over the region of interest and satellites besides the platforms and ground stations used during FFP-98.

Outcome:

4.3 Many interesting results emerged from these observations. The Indian results of FFP -98 of INDOEX have been published in a special issue of `Current Science` in April 1999 and the IFP-99 results being now published in its another special issue. The most important result was the presence of a thick extensive haze layer extending over some ten million square kilometers over Northern Indian ocean and the landmass while clear sky condition were observed south of ITCZ. It confirmed that air pollution has more than local implications. It has provided an interface between air quality and global warming, brought into focus the transcontinental nature of air pollution. The layer contained an appreciable amount of soot carbon reducing photo-synthetically active radiation and solar heating of the northern Indian ocean and of the region, 15 times larger than regional greenhouse forcing. Such reduction in sunlight could cause a significant loss in agriculture production and significant perturbation to the water budget of the region. The observations and trajectory analysis has clearly established that there are four possible channels in the vicinity of our continent including Gulf region, East Asia and our land mass itself which can contribute to these plumes or haze layers.

A matter of serious debate was the relative importance of bio-mass and fossil fuel burning and automobile exhaust. It appears that both fossil fuel consumption and biomass burning contribute to the haze. Major bio-mass burning are from rural cooking practices which, in this region, come predominantly from the wide use of fuel wood, cattle dung, charcoal and agriculture waste. A key requirement is a quantitative assessment of emissions of aerosols of different categories from different sources from the Indian subcontinent especially those of black carbon and organic carbon.

A FEW ISSUES

1. Measurement of Parameters and Use

The data collected was for the measurement of various atmospheric parameters including concentration of trace gases like O3, NOx, CO, CH4 etc; aerosols including their concentrations, size distribution, mass, chemical composition and optical depth, radiation fluxes and related meteorological parameters. Different platforms were used for in-situ measurement of these parameters. These measurements were also supported by modeling efforts including trajectory analysis. As a part of international INDOEX understanding, the data generated from this programme are housed in three international data centers which are inter-linked and located at;

I. National Physical Laboratory, New Delhi
II. C4, University of California, USA
III. LMD, France

Data will be available to the INDOEX community upto two years after the completion of the experiments and will be made available for general use after this period. However, the data collected in Indian EEZ, will not be released to foreigners for their use as per the recommendations of the Committee for Security and Sensitivity clearance of data.

2. Security and Sensitivity Aspect

Since this programme was international in nature, involving participation of foreign groups and platforms; a Committee for considering the security and sensitivity aspect of this programme was constituted to examine the various aspects of this programme. At the recommendations of this Committee, a Sub Group comprising of few selected members of National Steering Committee of INDOEX a representative each of Ministry of Defence and Ministry of Home, subsequently looked into the various types of data collected during the programme and provided clearance. The whole programme was however coordinated and managed through a duly constituted National Steering Committee under the Chairmanship of Dr.A.P. Mitra, and having its members from the participating institutions and sponsoring agencies.

3. Effect of Aerosols on Agriculture Yield

The effect of atmospheric aerosols and the regional haze from air pollution on the yields of rice and wheat grown in China has been assessed using some suitably devised model by Chameides et.al. in 1999. Model estimates indicate that the direct effect of regional haze results in 5-30% reduction in solar radiation reaching some of the China`s most important productive region. These calculations also suggest that this regional haze over China is currently depressing optimal yields of around 70% of the crops grown in China by 5 to 30%. Thus the model has indicated an 1:1 relationship between the percentage decrease in total surface solar radiation and the percentage decrease in the yields of rice and wheat.

4. Proposed Future Course of Action

There are serious consequences of the observed haze layer on monsoon changes, agriculture, health and water resources. Quantitative implications are now under study. INDOEX is expected to contribute new knowledge in to proper physicochemical characterization of polluting aerosols. Thus INDOEX results will help reduce uncertainties in our understanding of the role of aerosols on climate changes.

An international workshop was organized at the Institute of Himalayan Bioresource Technology, Palampur during October 9-13,2000 to address these issues and some key programmes were identified for future studies.

These include:

I. Study of effect of aerosols on monsoon, their onset, variability and effect on hydrological cycle.
II. Atmospheric chemistry experiment programme with provision for in situ observations on global scale with characterization of gases, transport, aerosols, radiations and their interaction.
III. A study of black carbon/carbonaceous particles and their role in atmospheric system.

5. Inter-tropical Convergence Zone (ITCZ)

The Inter-tropical Convergence Zone (ITCZ) is a zone where the mixing and convergence of two different air masses of northern and southern hemispheres takes place. This ITCZ contains numerous eddies and is characterized by deep convection which leads to the formation of extensive mid-and upper level cloud systems.

During the period of north-east monsoon (i.e. January-March), the ITCZ is located at about 10Â°South but moves northward towards tropics (i.e. about 20Â°N) during July-August period when south-west monsoon prevails over the Indian sub-continent.